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SCIENCE IN THE ACCREDITED HIGH SCHOOLS OF WASHINGTON

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There has never been any attempt to ascertain the extent of science teaching in the accredited high schools of the state of Washington. In seeking to determine the present status of instruction in science and the efforts being made to co-ordinate the science work of the secondary schools with science in the university, a questionnaire was sent to the 211 accredited high schools of the state. Returns from 147, or 69 per cent, of the schools furnish the basis for this report.

The total class enrolment, the number of teachers in the high school, the number of science teachers and their teaching combinations, the degrees held, and the years of experience were considered important in selecting the typical high school.

There is a total enrolment of 32,810 pupils in the 147 schools. There are 12,108 Freshmen, 8,831 Sophomores, 6,479 Juniors, and 5,392 Seniors. Of the 1,738 teachers represented, 291 are science teachers. One hundred and ninety-six of those teaching science have a Bachelor's or a Master's degree with a major or minor in science; 71 have a Bachelor's degree without a major or minor in science, and 24 have no degree, though the majority of these are working for a degree. This group of 291 science teachers represents a total of 1,756 years of teaching experience, or an average of 6+ years. Table I shows the total enrolment, the median enrolment, and the range of enrolment in each of the four high school grades for the 147 schools.

The typical high school in the state of Washington in terms of medians has an enrolment of 89 Freshmen, 82 Sophomores, 90 Juniors, and 80 Seniors. There are 11 teachers in the high school, two of whom are science teachers. Ten of the 11 teachers are college graduates. The majority of the accredited high schools are so small that the typical teacher has to teach from three to six subjects.

A recent study[1] concerning the market for prospective high-school teachers has shown that there is a wide range of teaching combinations and a general lack of "standard combinations." The data for the report were compiled from the applications for teaching positions placed at the Washington State College at Pullman and reports from the Washington State Department of Education.

According to the present study, during the school year 1920–21, mathematics was taught in combination with science in a majority of instances, this combination scoring 47 cases in the 147 schools reporting. History is second with 23 cases. Chemistry or physics is the principal science combined with mathematics, while a biological science is the next most frequent combination with mathematics.

TABLE I

ENROLMENT BY GRADES IN 147 ACCREDITED HIGH SCHOOLS

Grade	Actual Enrolment	Median Enrolment	Range of Enrolment
IX	12,108	89	4 to 900
X	8,831	82	4 to 755
XI	6,479	90	3 to 520
XII	5,392	80	1 to 477
Total	32,810	....	....

A second consideration was to determine (1) the number of schools offering the various sciences, (2) the number of units offered, (3) whether the science is elective or required, (4) whether it is required in the scientific course, (5) the year or years in which the course is offered, (6) the number of students in the course during the school year 1920–21, and (7) the number of recitation and laboratory periods per week and their length. There is a recitation and laboratory period plan that is generally recognized in all laboratory sciences. There are three recitation and two double laboratory periods of forty-five minutes each per week. To count as a "unit," a subject must be taught five times per week, in periods of not less than forty-five minutes, for a school year of not less than thirty-six weeks.

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[1] Aubrey A. Douglass, "The Market for Prospective High School Teachers," *School and Society*, XIII (May 21, 1921), 602–6.

Table II indicates the present status of the teaching of the various sciences in the accredited high schools in respect to the points mentioned.

Astronomy constitutes a small part of the science offered in the accredited high schools. There is no scientific curriculum where the science is offered. The course is required in the six schools giving it. All of the schools offering the subject are very small, which indicates that the science is supplementary in nature or that the course is offered to fill science requirements because the teacher happens to be trained in astronomy. Three of the schools offer the course in the Senior year, two in the Junior year, and one in the Sophomore year.

TABLE II

DATA CONCERNING THE TEACHING OF THE VARIOUS SCIENCES IN 147 ACCREDITED HIGH SCHOOLS

Science	Number of Schools Offering	Number of Units Offered	Elective in Addition to the Required Science?	Required for Graduation from Scientific Course?	Year or Years Offered	Number of Students during 1920–21
Astronomy	6	1	No	No	X, XI, XII	185
Biology	55	2	Yes	Yes	IX, X, XI	1,164
Botany	77	2 (8 schools) 1 (69 schools)	Yes	Yes	X, XI	2,417
Chemistry	83	2 (6 schools) 1 (77 schools)	No	Yes	XI, XII	2,406
General science	119	1	Yes	Yes	IX, X	6,340
Physical geography	29	.5	Yes	No	IX	519
Physics	131	1.5 (17 schools) 1 (114 schools)	Yes	Yes	XI, XII	2,588
Physiology	29	1	Yes	Yes	X, XI, XII	421
Psychology	7	1	Yes	No	XII	197
Zoölogy	16	1	Yes	Yes	X, XI	513

Many of the schools alternate the subject of biology with botany or zoölogy. This gives more science work in the curriculum and cares for a larger number of students. Botany and zoölogy are taught as separate subjects, though they constitute the subject of biology. Thirty-seven per cent of the schools reporting taught biology during the school year 1920–21. In the larger schools of the state where a scientific curriculum is offered, biology is required. Most of the schools are so small that the science offering is limited to one or two subjects. However, biology is found as an elective in the majority of schools. There are slight variations in the length of periods reported. For example, there are six schools reporting thirty-five and forty-minute periods. Forty-seven of the schools offer biology in the Sophomore year, five in the Junior year, and three in the Freshman year.

The study of the form and structure of plants has an important place among the sciences of the high-school curricula. Botany is in part a repetition of the biology course and is used as an alternate in many of the schools. Fifty-two per cent of the schools reporting taught botany during the school year 1920–21. Eight schools offer two years of botany work, and 69 schools one year. The course is confined to the Sophomore and Junior years. Being one of the more concrete sciences, it is best adapted to these years in the curriculum. Three recitation and two laboratory periods per week are required.

Chemistry, outside of the scientific course, is elective in a few of the largest schools. It is required in all scientific courses. Sixty-two of 83 schools offer chemistry in the Junior year and 21 in the Senior year. Most of the schools teach chemistry or physics in alternate years. Mathematics is the principal teaching combination with chemistry and physics. In cases where the domestic-science teacher teaches an additional subject, it is usually chemistry.

General science takes a major position in the science curriculum. Eighty-one per cent of the schools reporting offer general science. One hundred and fifteen schools offer it in the Freshman year, and four schools in the Sophomore year. More than 50 per cent of the first-year enrolment is represented in this course, although the subject has relatively little value in preparing for collegiate work. There is no definite laboratory arrangement for the teaching of general science in one-half of the schools. The course is supplemented by laboratory exercises in some of the schools.

Geology is not included in Table II because it is offered in but one school. There are 23 students enrolled in the course, and it is offered in the Senior year. The subject is required. Few teachers are prepared to teach geology, which is one reason for the absence of this subject from the high-school curricula. The commercial demand for trained men in geological work will make this subject a more important part of the high-school curricula in the future.

The teaching of physical geography is not very common in the high schools. The subject is primarily a Freshman subject and is taught in the first half of the Freshman year, one-half credit being offered. It is largely confined to the smaller high schools. The schools offering scientific curricula do not require it, although it is sometimes offered as an elective. Some schools offer a half-year of botany, zoölogy, or biology in combination with physical geography as a year's work in science. The small number of Freshmen electing this subject is indicative of limited interest in the course.

Physics takes the leading rôle among the sciences offered by the high schools. Ninety per cent of the schools offer physics regularly, and the remaining 10 per cent are represented among those schools offering chemistry as an alternate with physics. In schools that present scientific curricula physics is required in the Junior year. In the smaller schools where the academic course alone prevails, physics is elective in the Junior or Senior year. Since 70 per cent of the science teachers have a Master's or a Bachelor's degree with a major or minor in science, it is fair to assume that most of this number have had extensive training in physics or chemistry. With a few exceptions, these subjects are required in the science curricula of the universities and colleges.

Physiology is required in the pre-medic, pharmacy, physical-education, and domestic-science courses in the university, but it is seldom included in the high-school curriculum. Hygiene and other physiological courses have been supplemented, and the work in physiology has been carried over to the university, where more adequate instruction and better laboratory facilities are available. It has been suggested that this course should be offered where a sufficient number of high-school students wish to enter one of the courses mentioned as requiring physiology. Desirable as this may seem, a review of the medical colleges of the country shows but one instance where physiology is an entrance requirement. Most of these institutions prefer to teach the course in their own way; hence it is not included in the entrance requirements. Credit in physiology is accepted as a science entrance requirement in most universities.

There seems to be no definite place for the teaching of physiology in the high-school curriculum, and the comparatively small number enrolled in the course shows limited interest. However, physiology should be taught in the high school. Hygiene should be made supplementary. The teaching of physiology has served an end if the students have been made to feel their hygienic responsibility to each other. The cause of most preventable diseases is the ignorance of the individuals composing the group.

The present tendency in educational practice is toward the offering of psychology in the secondary curriculum. Though it takes a place with other abstract sciences, the educational value is in question because there is no standard basis of instruction. In the schools reporting there is no prescribed laboratory period in psychology, but the subject is taught five periods per week. The work in psychology is contributory to interpretations in other phases of school activity, and it will take considerable time to get this science well established in the secondary curriculum, as it has with all other sciences.

Zoölogy represents a small part of the science taught. Reference to Table II indicates the predominance of botany over zoölogy. Zoölogy or botany is required for graduation from schools offering scientific curricula. These sciences are generally offered in the Sophomore or Junior year. The reason for the predominance of botany can be ascribed to the fact that the agricultural communities of this state demand botany in the school. Teachers select botany as a teaching subject because the laboratory material is easily obtained. There is also a tendency to avoid sex problems, which naturally arise in the teaching of zoölogy.

CONCLUSIONS

A student taking the required subjects in any of the prescibed courses offered in some of the schools may choose as electives any subjects offered in any other course. The only limitation placed on the free choice of electives is that required subjects must come before electives and should be taken in their regular order. A great number of electives are open to students in the larger schools; the small schools meet this situation by alternating various subjects. This enables the students to develop their own interests.

College-entrance requirements are so varied that it does not seem possible to formulate a four-year high-school course that will meet the entrance requirements of all colleges. Many college students are compelled to spend a year's time working off some prerequisite to their course of study which should have been offered by the high school. A standard course of study with a wide range of electives would increase the effectiveness of correlation between the secondary and collegiate institutions of the state. The graduating high-school student should be able to enter the university without having to complete prerequisite courses which are offered in some of the high schools and should be standardized in all. Supervisors should be familiar with the entrance requirements of the colleges which their high-school graduates will probably attend. All possible concessions should be made to correlate the high-school and the college courses.

The present system of financing the schools prevents rapid progress in science teaching. Adequate teaching facilities and the proper laboratory materials are not available. The large schools draw the best and more specialized teachers. The smaller school has little equipment, and the science teacher is teaching two or three subjects. A high standard of teaching efficiency is seldom attained when teachers are compelled to teach subjects which they are not prepared to teach.

The consolidation of certain small outlying high schools into a central school would decrease the operating expenses. Adequate appropriations by a state commission to each of these central schools would give all of the people of the state equal educational advantages. Modern equipment could be supplied, and trained teachers in each phase of school work could be obtained. A greater range of electives could be included in the curriculum, and the standardization of courses could be established in closer correlation with the entrance requirements of the universities.